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PTO IDENTIFIER: **Application Number** 10/054,605-Conf. #8304
Patent Number

Inventor: Chao-Kun Hu

MESSAGE TO: Examiner Paul E. Brock, II

FAX NUMBER: (703) 872-9319

FROM: CONNOLLY BOVE LODGE & HUTZ LLP
Burton A. Amernick

PHONE: (202) 331-7111

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Attorney Dkt. #: YOR919990336US2/20140-00300-US

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Appendix of Claims on Appeal (in triplicate); and
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Certificate of Transmission under 37 CFR 1.8;
Appeal Brief Transmittal;
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TRANSMITTAL OF APPEAL BRIEF			Docket No. YOR919990336US2/ 20140-00300-US
In re Application of: Chao-Kun Hu			
Application No. 10/054,605-Conf. #8304	Filing Date November 13, 2001	Examiner Paul E. Brock, II	Group Art Unit 2815
Invention: REDUCED ELECTROMIGRATION AND STRESS INDUCED MIGRATION OF COPPER WIRES BY SURFACE COATING			

TO THE COMMISSIONER OF PATENTS:

Transmitted herewith in triplicate is the Appeal Brief in this application, with respect to the Notice of Appeal filed: August 4, 2003.

The fee for filing this Appeal Brief is 330.00.

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Dated: 10-3-03

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FEE TRANSMITTAL for FY 2004

Effective 10/01/2003. Patent fees are subject to annual revision.

☐ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT	($) 330.00

Complete if Known	
Application Number	10/054,605-Conf. #8304
Filing Date	November 13, 2001
First Named Inventor	Chao-Kun Hu
Examiner Name	Paul E. Brock, II
Art Unit	2815
Attorney Docket No.	YOR919990336US2/ 20140-00300-US

METHOD OF PAYMENT (*check all that apply*)

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Deposit Account Name: IBM CORPORATION

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FEE CALCULATION

1. BASIC FILING FEE

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1001	770	2001	385	Utility filing fee	
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	

SUBTOTAL (1) ($) 0.00

2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

			Extra Claims		Fee from below		Fee Paid
Total Claims		-** =		x		=	
Independent Claims		-** =		x		=	
Multiple Dependent						=	

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description
1202	18	2202	9	Claims in excess of 20
1201	86	2201	43	Independent claims in excess of 3
1203	290	2203	145	Multiple dependent claim, if not paid
1204	86	2204	43	** Reissue independent claims over original patent
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent

SUBTOTAL (2) ($) 0.00

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FEE CALCULATION (continued)

3. ADDITIONAL FEES

Large Entity Fee Code	Large Entity Fee ($)	Small Entity Fee Code	Small Entity Fee ($)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge – late filing fee or oath	
1052	50	2052	25	Surcharge – late provisional filing fee or cover sheet.	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for *ex parte* reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	475	Extension for reply within third month	
1254	1,480	2254	740	Extension for reply within fourth month	
1255	2,010	2255	1,005	Extension for reply within fifth month	
1401	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing a brief in support of an appeal	330.00
1403	290	2403	145	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive – unavoidable	
1453	1,330	2453	665	Petition to revive - unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	770	2809	385	Filing a submission after final rejection (37 CFR 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37CFR 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	

Other fee (specify) ______

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SUBMITTED BY

(Complete (*if applicable*))

Name (Print/Type)	Burton A. Amernick	Registration No. (Attorney/Agent)	24,852	Telephone	(202) 331-7111
Signature	[signature]			Date	10-3-03

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Dated: 10-3-03 Signature: Michele Stoddard

13/Appeal Brief
P. Walker
10-8-03

Docket No.: YOR919990336US2
(20140-00300-US)
(PATENT)

BEFORE THE USPTO BOARD OF PATENT APPEALS AND INTERFERENCES
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of: Chao-Kun Hu	Conf. No. 8304
Application No.: 10/054,605	Group Art Unit: 2815
Filed: November 13, 2001	Examiner: Paul E. Brock, II
For: REDUCED ELECTROMIGRATION AND STRESS INDUCED MIGRATION OF COPPER WIRES BY SURFACE COATING	

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APPEAL BRIEF UNDER 37 CFR 1.192

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Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

This an appeal to the Primary Examiner's Final Rejection of claims 1-5, 7-10, 18-22, 24-27 and 35-38 (all of the claims now pending in the application).

1) REAL PARTY IN INTEREST

The real party in interest is International Business Machines Corporation.

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2) RELATED APPEALS AND INTERFERENCES

There are no other appeals or interferences known to appellant, appellant's legal representative or assignee which will directly affect or be directly affected by or have a bearing

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on the Board's decision in this appeal.

3) STATUS OF CLAIMS

Claims 1-5, 7-10, 18-22, 24-27 and 35-38 are pending and are all on appeal. Claims 6, 11-17, 23 and 28-34 have been cancelled.

4) STATUS OF AMENDMENTS

The amendment to the claims filed after the final rejection has been entered.

5) SUMMARY OF INVENTION

The present invention relates to a metal surface coating or treatment to prevent surface atoms of conductors from being moved downstream by an electron current, a phenomena known as electromigration, and/or from being moved by a stress gradient tending to relax stress known as stress induced migration.

More particularly, the present invention provides a thin metal layer in the range from 1 to 20 nm in order to reduce susceptibility to electromigration, oxidation, corrosion, stress voiding and delamination during subsequent chip processing and/or chip utilization, thus improving reliability and yield.

The thin metal layer forms a metal to metal metallurgical with an underlying patterned conductor as a substrate as recited in claim 18 and claims dependent thereon.

Another aspect of the present invention, as recited in claim 1 and claims dependent thereon, relates to a method for forming conductors with high electromigration resistance. The process comprises forming a layer of dielectric on a substrate, forming at least one trench in the layer of dielectric, forming a metal liner in the trench, forming a conductor on the metal liner filling the trench, forming a planarized upper surface of the conductor planar with the upper surface of the layer of dielectric, and forming a conductive film over the upper surface of said conductor, the conductive film forming a metal to metal metallurgical bond, and wherein the conductive film has a thickness of 1 to 20 nanometers.

6) ISSUES

A. Has the examiner established that claims 1-4, 18, 19, 20 and 21 are obvious and therefore unpatentable under 35 USC 103(a) over the cited art and namely US Patent 5,695,810 to Dubin in view of US Patent 6,077,774 to Hong?

B. Has the examiner established that claims 5, 7, 22, 24, 37 and 38 are obvious and therefore unpatentable under 35 USC 103(a) over the cited art and namely US Patent 5,695,810 to Dubin in view of US Patent 6,077,774 to Hong and in view US Patent 5,674,787 to Zhao?

C. Has the examiner established that claims 1, 9, 10, 18, 26 and 27 are obvious and therefore unpatentable under 35 USC 103(a) over the cited art and namely US Patent 6,372,633 to Maydan in view of US Patent 6,077,774 to Hong?

D. Has the examiner established that claims 1, 2, 18 and 19 are obvious and therefore unpatentable under 35 USC 103(a) over the cited art and namely US Patent 6,180,523 in view of US Patent 6,077,774 to Hong?

E. Has the examiner established that claims 8, 25, 35 and 36 are obvious and therefore unpatentable under 35 USC 103(a) over the cited art and namely US Patent 6,180,523in view of US Patent 6,077,774 to Hong and in view US Patent 5,674,787 to Zhao?

7) GROUPING OF CLAIMS

For each rejection, all of the involved claims stand or fall together.

8) APPELLANT'S ARGUMENTS

A. Dubin and Hong Fail to Render Obvious Claims 1-4, 18, 19, 20 and 21

Claims 1-4, 18, 19, 20 and 21 have been rejected under 35 U.S.C. § 103 as being unpatentable over Dubin in view of Hong. The cited references do not render obvious the present invention.

The present invention relates to a metal surface coating or treatment to prevent surface atoms of conductors from being moved downstream by an electron current, a phenomena known

as electromigration, and/or from being moved by a stress gradient tending to relax stress known as stress induced migration.

More particularly, the present invention provides a thin metal layer in the range from 1 to 20 nm in order to reduce susceptibility to electromigration, oxidation, corrosion, stress voiding and delamination during subsequent chip processing and/or chip utilization, thus improving reliability and yield.

The thin metal layer forms a metal to metal metallurgical bond with an underlying patterned conductor as a substrate.

The cited references fail to render obvious the above claims since, as appreciated by the Examiner, Dubin fails to suggest a conductive film over the upper surface of the conductor having a thickness of 1 to 20 nanometers. In fact, Dubin seems to suggest a film of 150-200 nanometers thick (see column 6, lines 20-22). Dubin relates to electrolessly depositing a CoWP film. Crucial to the suggestions in Dubin is the CoWP film (e.g., see column 2, line 63 to column 3, line 20). Furthermore, electroless deposition is important in the suggestions of Dubin. Along these lines (see column 8, lines 39-51). The film of Dubin is orders of magnitude greater than that of the present invention.

Hong was relied upon for a disclosure of 9 nanometers. However, Hong is not even properly combinable with Dubin since, among other things, Hong does not relate to CoWP films which are essential according to Dubin. Instead Hong suggests a layer of metallic oxide or carbide such as Al_2O_3, Cr_2O_3, TiO_2, AlC, TiC or CrC. (see column 5, lines 19-21).

Moreover, Hong does not suggest employing electroless deposition for forming such a layer as required by Dubin. Also see claims 2, 4, 5, 6, 7, 8, 19, 21, 22, 24, 25, 35 and 36 of the present application. Critical to the suggestions of Hong is the use of a specific chemical vapor deposition technique. In fact at column 1, lines 29-36, Hong discusses problems of depositing their film, which are to be addressed by the particular techniques suggested therein. Accordingly, use of electroless deposition would be contrary to the suggestions in Hong.

There is no motivation listed in the cited art to combine Hong and Dubin. As discussed in the specification, the resistivity of the Cu line is not affected or increased by more than 20%;

the electrical leakage is eliminated; and no further planarization of the Cu line is needed.

B. Dubin in view of Hong and Zhao Fail to Render Obvious Claims 5, 7, 22, 24, 37 and 38

Claims 5, 7, 22, 24, 37 and 38 have been rejected over Dubin in view of Hong and in view of Zhao.

Zhao fails to overcome the above discussed deficiencies of Dubin and Hong with respect to rendering obvious the present invention. In particular, Zhao was merely relied upon for a disclosure of annealing. However, Zhao is not even properly combinable with Dubin since, among other things, Zhao does not suggest CoWP film required by Dubin. The capping layers suggested by Zhao are 500-1500 angstroms (i.e. -50-150 nanometers) (see column 8, lines 18-31) and include Ni-Co, CoP, NiCoP or NiP (see column 8, lines 12-15).

C. Maydan in view of Hong Fail to Render Obvious Claims 1, 9, 10, 18, 26 and 27

Claims 1, 9, 10, 18, 26 and 27 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Maydan et al. in view of Hong. Maydan fails to render obvious the above claims since, among other things, Maydan does not relate to the problems addressed by the present invention and does not even remotely disclose the importance of the thickness of a metal barrier layer.

The above discussion of Hong is incorporated herein by reference. Hong does not overcome the above discussed deficiencies of Maydan with respect to rendering obvious the above claims. In fact, Hong is not even properly combinable with Maydan since Hong suggests a layer of an oxide or carbide such as $A1_2O_3$, Cr_2O_3, TiO_2, A1C, TiC, or CrC; whereas, Maydan refers to W. No motivation exists in the cited art to combine Maydan and Hong.

D. Lee in view of Hong Fail to Render Obvious Claims 1, 2, 18 and 19

Claims 1, 2, 18 and 19 were rejected under 35 U.S.C. § 103(a) as being unpatentable over Lee in view of Hong. The cited references fail to render obvious the above claims.

Lee relates to an electrodes plating process but fails to even remotely suggest the

thickness of the conductive film as employed according to the present invention. Critical to the process discussed by Lee is the electroless metallization. In addition, with respect to claim 1 and claims dependent thereon, Lee does not suggest forming a planarized upper surface of the conductor as recited in these claims. Moreover, since Lee requires subsequent insulation layer and patterning the insulation layer, forming the planarized upper surface does not seem to be especially suitable in Lee.

The above discussion of Hong is incorporated herein by reference.

Hong was relied upon for a disclosure of 9 nanometers. However, Hong is not even properly combinable with Lee since, among other things, Hong does not suggest employing electroless deposition for forming the conductive layer as required by Lee. Critical to the suggestions of Hong is the use of a specific chemical vapor deposition technique. In fact at col. 1, lines 29-36, Hong discusses problems of depositing their film, which are to be addressed by the particular techniques suggested therein. Accordingly, use of electroless deposition as required by Lee would be contrary to the suggestions in Hong.

E. Lee in view of Hong and Zhao Fail to Render Obvious Claims 8, 25, 35 and 36

Zhao fails to overcome the above discussed deficiencies of Lee and Hong with respect to rendering obvious the present invention. In particular, Zhao was merely relied upon for a disclosure of annealing. However, it would not be obvious to employ the annealing of Zhao since Lee was aware of Zhao (see column 4, lines 49-52) and it seems logical that Lee would have discussed annealing if such were deemed appropriate for the process of Lee. The capping layers suggested by Zhao are 500-1500 angstroms (i.e. -50-150 nanometers) (see column 8, lines 18-31) which lead away from the thickness recited in the present claims.

Discussion of Relevant Case Law

The mere fact that cited art may be modified in the manner suggested by the Examiner does not make this modification obvious, unless the cited art suggest the desirability of the modification. No such suggestion appears in the cited art in this manner. The Examiner's

50 USPQ2d. 1614 (Fed. Cir. 1999), *In re Gordon*, 221 USPQ 1125 (Fed. Cir. 1984), *In re Laskowski*, 10 USPQ2d. 1397 (Fed. Cir. 1989) and *In re Fritch*, 23 USPQ2d. 1780 (Fed. Cir. 1992).

In Dembiczak et al., supra, the Court at 1617 stated: "Our case law makes clear that the best defense against the subtle but powerful attraction of a hindsight-based obviousness analysis is rigorous application of the requirement for a showing of the teaching or motivation to combine prior art references. See. E.g., C.R. Bard, Inc., v. M3 Sys., Inc., 157 F.3d. 1340, 1352, 48 USPQ2d. 1225, 1232, (Fed. Cir. 1998) (describing 'teaching or suggestion motivation [to combine]' as in 'essential evidentiary component of an obviousness holding'), In re Rouffet, 149 F.3d 1350, 1359, 47 USPQ2d. 1453, 1459 (Fed. Cir. 1998)('the Board must identify specifically…the reasons one of ordinary skill in the art would have been motivated to select the references and combine them');…".

Moreover, it is impermissible under 35 U.S.C. 103 to use hindsight reconstruction to pick and choose among isolated disclosures in the prior art to deprecate the claimed invention. See *In re Fine*, 5 USPQ2d 1596 (Fed. Cir. 1988). Furthermore, it is well settled that hindsight reconstruction using the patent application as a guide through the maze of prior art references, combining "the right references in the right way" so as to achieve the result of the claimed invention must be avoided. See *Grain Processing Corp. v. American Maize-Products Corp.*, 5 USPQ2d 1788 (Fed. Cir. 1988).

The prior art fails to provide the degree of predictability of success of achieving the properties attained by the present invention needed to have a rejection under 35 U.S.C. 103 sustained. See *In re Mercier*, 187 USPQ 774 (CCPA, 1975) and *In re Naylor*, 152 USPQ 106 (CCPA, 1966).

Moreover, the properties of the subject matter and improvements which are inherent in the claimed subject matter and disclosed in the specification are to be considered when evaluating the question of obviousness under 35 USC 103. See *Gillette Co. v. S.C. Johnson & Son, Inc.*, 16 USPQ2d. 1923 (Fed. Cir. 1990), *In re Antonie*, 195, USPQ 6 (CCPA 1977), *In re Estes*, 164 USPQ (CCPA 1970), and *In re Papesch*, 137 USPQ 43 (CCPA 1963).

Estes, 164 USPQ (CCPA 1970), and *In re Papesch*, 137 USPQ 43 (CCPA 1963).

No property can be ignored in determining patentability and comparing the claimed invention to the cited art. Along these lines, see *In re Papesch*, supra, *In re Burt et al*, 148 USPQ 548 (CCPA 1966), *In re Ward*, 141 USPQ 227 (CCPA 1964), and *In re Cescon*, 177 USPQ 264 (CCPA 1973).

8) CONCLUSIONS

In view of the above it is abundantly clear that the Primary Examiner has erred in finally rejecting claims 1-5, 7-10, 18-22, 24-27 and 35-38. Accordingly, it is hereby requested that the Board reverse the examiner and allow claims 1-5, 7-10, 18-22, 24-27 and 35-38.

The Commissioner is hereby authorized to charge any fees or credit any overpayment associated with this communication including any extension fees to Deposit Account No. 50-0510.

Dated: 10-3-03

Respectfully submitted,

By

Burton A. Amernick
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APPENDIX OF CLAIMS ON APPEAL

1. (Previously Presented) A method for forming conductors with high electromigration resistance comprising

forming a layer of dielectric on a substrate,

forming at least one trench in said layer of dielectric,

forming a metal liner in said trench,

forming a conductor on said metal liner filling said trench,

forming a planarized upper surface of said conductor planar with the upper surface of said layer of dielectric, and

forming a conductive film over said upper surface of said conductor, said conductive film forming a metal to metal metallurgical bond

and wherein said conductive film has a thickness of 1 to 20 nanometers.

2. (Original) The method of claim 1 wherein said step of forming a conductive film includes the step of forming said conductive film by electroless deposition whereby said upper surface of said conductor is protected from oxidation and corrosion and provides high electromigration resistance and high resistance to thermal stress voiding.

3. (Previously Presented) The method of claim 1 wherein said conductive film has a thickness in the range of 1 to 10 nanometers.

4. (Original) The method of claim 2 wherein said electroless deposited film has a thickness in the range of 1 to 10 nanometers.

5. (Previously Presented) The method of claim 2 wherein said electroless deposition includes first immersing said substrate in a solution of metal ions whereby a layer of nanoparticles of metal are formed on said upper surface of said conductor,

second immersing said substrate in an electroless complexed solution of metal ions and hypophosphite ions whereby said conductive film formed comprises a metal-phosphide conductive film on said upper surface of said conductor, and

annealing said substrate in one of an inert or reducing atmosphere at a temperature of at least 300° C for at least 2 hours whereby excellent adhesion is obtained between said conductor and said metal phosphide conductive film.

7. (Previously Presented) The method of claim 5 wherein said conductive film is selected from the group consisting of CoWP, CoSnP, and CoP.

8. (Previously Presented) The method of claim 2 wherein said electroless deposition includes first immersing said substrate in a solution of metal ions whereby a layer of nanoparticles of metal are formed on the surface of said conductor,

second immersing said substrate in an electroless complexed solution of metal ions and dimethylamino borane whereby said conductive film formed comprises a layer of metal-boron conductive film on said upper surface of said conductor and,

annealing said substrate in one of an inert or reducing atmosphere at a temperature of at least 300° C for at least 2 hours whereby excellent adhesion is obtained between said conductor and said metal boron conductive film.

9. (Original) The method of claim 1 wherein said conductive film is applied on the surface of said conductor by physical methods such as Chemical Vapor Deposition (CVD), Physical Vapor Deposition (PVD), evaporation, sputtering and thermal metal interdiffusion.

10. (Original) The method of claim 9 wherein said conductive film is selected from the group consisting of Pd, In, W and mixtures thereof.

18. (Previously Presented) A method for forming conductors with high electromigration resistance comprising:

forming a patterned conductor on a substrate,

forming a conductive film over said surface of said conductor, said conductive film forming a metal to metal metallurgical bond and has a thickness of 1 to 20 nanometers.

19. (Original) The method of claim 18 wherein said step of forming a conductive film includes the step of forming said conductive film by electroless deposition whereby said surface of said conductor is protected from oxidation and corrosion and provides high electromigration resistance and high resistance to thermal stress voiding.

20. (Previously Presented) The method of claim 18 wherein said conductive film has a thickness in the range of 1 to 10 nanometers.

21. (Original) The method of claim 19 wherein said electroless deposited film has a thickness in the range of 1 to 10 nanometers.

22. (Previously Presented) The method of claim 19 wherein electroless deposition includes of first immersing said substrate in a solution of metal ions whereby a layer of nanoparticles of metal are formed on said surface of said conductor,

second immersing said substrate in an electroless complexed solution of metal ions and hypophosphite ions whereby said conductive film formed comprises a metal-phosphide conductive film on said surface of said conductor, and

annealing said substrate in one of an inert or reducing atmosphere at a temperature of at least 300° C for at least 2 hours whereby excellent adhesion is obtained between said conductor and said metal phosphide conductive film

24. (Previously Presented) The method of claim 22 wherein said conductive film is selected from the group consisting of CoWP, CoSnP, and CoP.

25. (Previously Presented) The method of claim 19 wherein said electroless deposition includes first immersing said substrate in a solution of metal ions whereby a layer of nanoparticles of metal are formed on the surface of said conductor,

second immersing said substrate in an electroless complexed solution of metal ions and dimethylamino borane whereby said conductive film formed comprises a layer of metal-boron conductive film on said surface on said conductor, and

annealing said substrate in one of an inert or reducing atmosphere at a temperature of at least 300° C for at least 2 hours whereby excellent adhesion is obtained between said conductor and said metal boron conductive film.

26. (Original) The method of claim 18 wherein said conductive film is applied on the surface of said conductor by physical methods such as Chemical Vapor Deposition (CVD), Physical Vapor Deposition (PVD), evaporation, sputtering and thermal metal interdiffusion.

27. (Original) The method of claim 26 wherein said conductive film is selected from the group consisting of Pd, In, W and mixtures thereof.

35. (Original) The method of claim 8 wherein said conductive film is selected from the group consisting of CoB, CoSnB, CoWB and NiB.

36. (Original) The method of claim 25 wherein said conductive film is selected from the group consisting of CoB, CoSnB, CoWB and Nib.

37. (Previously Presented) The method of claim 2 wherein said electroless deposition for forming said conductive film comprises immersing said substrate in an electroless complexed solution of metal ions and hypophosphite ions whereby a metal-phosphide conductive film is

formed on said upper surface of said conductor, and

annealing said substrate in one of an inert or reducing atmosphere at a temperature of at least 300° C for at least 2 hours whereby excellent adhesion is obtained between said conductor and said metal phosphide conductive film.

38. (Previously Presented) The method of claim 19 wherein said electroless deposition for forming said conductive film comprises immersing said substrate in an electroless complexed solution of metal ions and hyposphosphite ions whereby a metal-phosphide conductive film is formed on said surface of said conductor, and

annealing said substrate in one of an inert or reducing atmosphere at a temperature of at least 300°C for at least 2 hours whereby excellent adhesion is obtained between said conductor and said metal phosphide conductive film.